

Amendments to the Drawings

Attached is a proposed Figure 7.

REMARKS

As requested by the Examiner in the outstanding Office Action, Applicants are enclosing herewith a proposed Figure 7 which illustrates "cooling the graphite electrode which protrudes upward from the furnace roof by spraying a cooling liquid onto the surface of the graphite electrode". Entry of Figure 7 is respectfully solicited.

Claims 1-3 have been rejected under 35 USC 103(a) as being unpatentable over Sakurai et al in view of Markarian et al. Applicants respectfully traverse this ground of rejection and urge reconsideration in light of the following comments.

The presently claimed invention is directed to a graphite electrode provided in an electric arc furnace used for steelmaking in which an upper portion of the graphite electrode protrudes through the roof of the electric arc furnace and is cooled by spraying a cooling liquid on the upper portion of the graphite electrode in which the improvement comprises a cooling groove is provided in the surface of the upper portion of the graphite electrode for carrying the cooling liquid on the upper portion of the graphite electrode.

As discussed in the present specification, graphite electrodes are typically used in electric arc furnaces used in steelmaking processes. The tip portion of the electrode rapidly wears away due to slug corrosion and the like and must be replenished from outside of the furnace by connecting graphite electrodes in succession. The outer surface of the graphite electrode tends to oxidize and become consumed due to an increase in the temperature of the electrode to thereby increase the electrode consumption rate. In order to suppress the oxidation and consumption of the outer surface of the electrode, a cooling liquid has been sprayed onto the surface of the graphite electrode at a location above the furnace roof. However, the cooling effect is decreased because the

surface of the electrode is hydrophobic and repels the cooling liquid so that the oxidation prevention effect is hindered.

The presently claimed invention was achieved after studies by the inventors which found that the hydrophilicity of the surface of the graphite electrode of an electric arc furnace could be improved by forming an uneven structure thereon. That is, with the claimed uneven structure provided on the upper portion of the surface of the graphite electrode which protrudes through the roof of the electric arc furnace, the graphite electrode is given larger water retention characteristics which improves the cooling effect and reduces the electrode consumption rate by preventing oxidation and consumption. The presently claimed invention is based on this discovery and it is respectfully submitted that the prior art cited by the Examiner does not disclose the structure of the presently claimed invention.

The Sakurai et al reference discloses a method for cooling graphite electrodes which is discussed in the present specification. That is, this reference discloses the use of cooling water sprayed directly onto the outer periphery surface of at least one graphite electrode to cool the electrode. However, this reference does not disclose the cooling groove provided in the outer surface of the electrode as required by the current claims. Therefore, the secondary reference cited by the Examiner must provide the motivation to one of ordinary skill in the art to modify the Sakurai et al reference in a manner that would yield the presently claimed invention. It is respectfully submitted that the secondary reference contains no such disclosure.

The Markarian et al reference discloses an electric-arc furnace electrode assembly in which a pair of carbonaceous electrode sections are held securely in end-to-end relationship by a pin threaded into a pair of sockets formed in the respective ends of the electrode sections. The electrode section 68 has a socket provided therein and a barrel-shaped pin 70 is engaged with the socket. This

reference has no disclosure with respect to providing a thread on the outer surface of the electrode section 68 which is provided above a roof of an electric-arc furnace to aid in the cooling of the electrode. As such, this reference adds nothing to the previously discussed reference and does not even present a showing of prima facie obviousness under 35 USC 103 in combination with the primary reference.

Although the Examiner has not made a proper showing of prima facie obviousness under 35 USC 103, the test data contained in the present application shows the criticality of providing the groove in the surface of the graphite electrode. As shown in Table 1 on page 8 of the present specification, the electrodes according to the present invention had a much greater amount of water retention than the comparative electrode which had a smooth outer surface as shown by the primary Sakurai et al reference. This results in the reduced rate of electrode consumption which is clearly not suggested by any of the references cited by the Examiner. Therefore, the patentability of the presently claimed invention over the prior art cited by the Examiner has been established.

The Examiner is respectfully requested to reconsider the present application and to pass it to issue.

Respectfully submitted,

TFC/smd


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Encl: Replacement Abstract
Replacement Section - Disclosure of the Invention
Proposed Figure 7
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DISCLOSURE OF THE INVENTION

An artificial graphite electrode for an electric arc furnace used for steelmaking is produced by adding a ~~binder~~pitch binder to raw material coke, and kneading the mixture, followed by extrusion, primary baking, pitch impregnation, rebaking, graphitization, and machining into predetermined dimensions. The graphite electrode shows better characteristics as the graphitization progresses. However, hydrophilicity of the surface of the electrode tends to decrease as the graphitization progresses. Therefore, in the case of cooling the graphite electrode for steelmaking by spraying a cooling liquid onto the surface of the graphite electrode, the cooling effect is decreased since the surface of the electrode repels the cooling liquid, whereby the oxidation prevention effect cannot be obtained sufficiently.

The present inventors have conducted a number of experiments and studies on the structure of the electrode for obtaining hydrophilicity of the surface of the graphite electrode for an electric arc furnace used for steelmaking which is sufficiently graphitized and has good characteristics for use, and found that hydrophilicity can be obtained by forming an uneven structure on the surface of the electrode, whereby the cooling effect can be increased.

The present invention has been achieved based on the above findings. An object of the present invention is to provide a graphite electrode for an electric arc furnace used for steelmaking ~~used for~~in an electric steelmaking furnace operated while cooling the graphite electrode which protrudes upward from the furnace roof, which has large water retention characteristics, provides a sufficient cooling effect, and reduces the electrode consumption rate by preventing oxidation and consumption.

In order to achieve the above object, the present invention provides a graphite electrode for an electric arc furnace used for steelmaking which is operated while cooling the graphite electrode which protrudes upward from the furnace roof by spraying a cooling liquid onto the surface of the graphite electrode, wherein an uneven structure is formed on the surface of the graphite electrode.